

TITLE

**DISPLAY DEVICE WITH POWER
INTERRUPTION DELAY FUNCTION**

CLAIM OF PRIORITY

This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C §119 from an application entitled *Display Apparatus With Power Interruption Delay Function* earlier filed in the Korean Industrial Property Office on 30 August 1996, and there duly assigned Serial No. 96-37143 by that Office.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates in general to a display device employing a cathode ray tube, and more particularly to a display device with a power interruption delay function, in which a power interruption delay charging circuit is provided to prevent a horizontal output transistor from being damaged due to an instantaneous surge current generated when power supply is resumed under the condition that a high voltage charged on a horizontal deflection coil and an S-correction capacitor is not sufficiently discharged after power interruption.

Description of the Prior Art

Generally, a horizontal deflection circuit is supplied with power from a power supply circuit and controlled in operation by a microcomputer. Such a horizontal deflection circuit is an essential component of a display device.

1 Generally, in a display device a power supply circuit is adapted to convert commercial
2 alternating current (AC) input power into direct current (DC) power to supply desired voltages to
3 the horizontal deflection circuit and a control unit incorporating a microcomputer. The
4 microcomputer is adapted to control the operations of the horizontal deflection circuit and the power
5 supply circuit. The horizontal deflection circuit is adapted to horizontally deflect electron beams
6 emitted from a cathode ray tube. An exemplary horizontal deflection circuit may include a pulse
7 width modulation (PWM) controller for generating a PWM signal under the control of the
8 microcomputer, a current amplifier for amplifying current in response to the PWM signal from the
9 PWM controller, a horizontal/vertical (H/V) processor for driving a horizontal driver under the
10 control of the microcomputer, an H/V processor constant voltage circuit for supplying a constant
11 voltage to the H/V processor to drive it, and a horizontal output circuit for supplying current to a
12 horizontal deflection coil and an S-correction capacitor in response to output signals from the current
13 amplifier and horizontal driver.

14 The operation of the horizontal deflection circuit of the exemplary display device with the
15 above-mentioned construction will hereinafter be described.

16 When the display device is powered on, the PWM controller is operated under the control
17 of the microcomputer to output the PWM signal to the current amplifier and a high voltage from the
18 high voltage source is transferred to the horizontal deflection coil and the S-correction capacitor.

19 Under the above condition, the H/V processor outputs a horizontal pulse signal of square
20 wave to the horizontal driver under the control of the microcomputer. As a result, the high voltage
21 charged on the horizontal deflection coil and S-correction capacitor is discharged to a ground voltage
22 terminal.

1 Thereafter, when the square wave pulse signal from the H/V processor is changed from high
2 to low in level, and the high voltage from the horizontal deflection coil and S-correction capacitor
3 is no longer discharged.

4 Then, the high voltage from the high voltage source is again transferred to the horizontal
5 deflection coil and S-correction capacitor. Hence, the above-mentioned operation is repeated.

6 Noticeably, the horizontal deflection coil is mounted to a neck portion of a display device
7 so that electron beams can be deflected to the left or right according to a direction of current flowing
8 through the coil.

9 The S-correction capacitor applies a parabola voltage to the horizontal deflection coil to
10 correct a linearity of center-to-left and right sides of a screen of the display device. The S-correction
11 capacitor also performs a DC interruption function for preventing DC current from flowing to the
12 horizontal deflection coil.

13 If the power supply to the display device is interrupted during the operation of the display
14 device, the H/V processor constant voltage circuit operates no longer due to interruption of the
15 voltage. As a result, the H/V processor operates no longer, as well.

16 As the H/V processor operates no longer, it outputs no pulse signal thereby causing the high
17 voltage charged on the horizontal deflection coil and S-correction capacitor not to be discharged.
18 As a result, a voltage of about +120 to 160 V remains.

19 Under the above condition, if the power supply to the display device is resumed, the H/V
20 processor constant voltage circuit is driven because of application of a voltage so as to operate the
21 H/V processor, a high voltage with a very high peak value (about +1.5 to 1.8KV) is instantaneously
22 generated. As a result, a surge current resulting from the instantaneous high voltage abruptly flows
23 through a discharge loop damaging a portion of the horizontal output circuit.

1 If the horizontal output circuit is damaged, no horizontal deflection is performed on the
2 screen of the display device, thereby causing a single line to be vertically drawn on the center of the
3 screen. As a result, the user cannot recognize the information displayed on the screen.

4 Further, the peripheral devices and circuits may successively be damaged due to a short-
5 circuit resulting from the damage in the horizontal output circuit.

6 SUMMARY OF THE INVENTION

7 Therefore, the present invention has been made in view of the above problems, and it is an
8 object of the present invention to provide a display device with a power interruption delay function,
9 in which a power interruption delay charging circuit is provided to prevent a horizontal output
10 transistor from being damaged due to an instantaneous surge current generated when power supply
11 is resumed under the condition that a high voltage charged on a horizontal deflection coil and an S-
12 correction capacitor is not sufficiently discharged after power interruption.

13 In accordance with the present invention, the above and other objects can be accomplished
14 by a provision of a display device with a power interruption delay function, comprising a pulse width
15 modulation controller for generating a pulse width modulation signal under the control of a
16 microcomputer; a current amplifier for amplifying current in response to the pulse width modulation
17 signal from the pulse width modulation controller; an H/V processor for generating a square wave
18 pulse signal under the control of the microcomputer; a horizontal driver for generating a drive pulse
19 signal in response to the square wave pulse signal from the H/V processor; a horizontal deflection
20 coil for horizontally deflecting electron beams; an S-correction capacitor connected in series to the
21 horizontal deflection coil, for correcting a linearity of center-to-left and right sides of a screen; a
22 horizontal output circuit for charging and discharging energy on the horizontal deflection coil and
23 S-correction capacitor in response to an output signal from the current amplifier and the drive pulse

1 signal from the horizontal driver; an H/V processor constant voltage circuit for supplying a constant
2 voltage to the H/V processor; and power interruption delay charging means for gradually lowering
3 an input voltage to the H/V processor constant voltage circuit when power supply to the display
4 device is interrupted.

5 BRIEF DESCRIPTION OF THE DRAWINGS

6 A more complete appreciation of the present invention, and many of the attendant
7 advantages thereof, will become readily apparent as the same becomes better understood by
8 reference to the following detailed description when considered in conjunction with the
9 accompanying drawings in which like reference symbols indicate the same or similar components,
10 wherein:

11 Fig. 1 is a schematic block diagram illustrating the construction of a horizontal deflection
12 circuit of a display device;

13 Fig. 2 is a detailed circuit diagram of the horizontal deflection circuit of the display device
14 in Fig. 1;

15 Fig. 3 is a detailed circuit diagram illustrating the construction of a display device with a
16 power interruption delay function in accordance with the principles of the present invention;

17 Figs. 4a and 4b are waveform diagrams showing comparison between inputs to H/V
18 processor constant voltage circuits in Figs. 2 and 3; and

19 Figs. 5a and 5b are waveform diagrams showing comparison between outputs of H/V
20 processors in Figs. 2 and 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a schematic block diagram illustrating the construction of a horizontal deflection circuit of a display device. In this drawing, the reference numeral 110 designates a microcomputer, 120 designates a power supply circuit and 130 designates a horizontal deflection circuit.

The power supply circuit 120 is adapted to convert commercial alternating current (AC) input power into direct current (DC) power to supply desired voltages to the horizontal deflection circuit 130 and the microcomputer 110.

The microcomputer 110 is adapted to control the operations of the horizontal deflection circuit 130 and power supply circuit 120.

The horizontal deflection circuit 130 is adapted to horizontally deflect electron beams emitted from a cathode ray tube.

The horizontal deflection circuit 130 includes a pulse width modulation (PWM) controller 135 for generating a PWM signal under the control of the microcomputer 110, a current amplifier 136 for amplifying current in response to the PWM signal from the PWM controller 135, an H/V processor 132 for driving a horizontal driver 133 under the control of the microcomputer 110, an H/V processor constant voltage circuit 131 for supplying a constant voltage to the H/V processor 132 to drive it, and a horizontal output circuit 134 for supplying current to a horizontal deflection coil H-DY and an S-correction capacitor Cs in response to output signals from the current amplifier 136 and horizontal driver 133.

Fig. 2 is a detailed circuit diagram of the horizontal deflection circuit 130 of the display device in Fig. 1. As shown in this drawing, the current amplifier 136 includes a current amplification transformer T1 having primary and secondary coils, and a field effect transistor FET1 having its gate terminal connected to the secondary coil of the current amplification transformer T1.

1 The primary coil of the current amplification transformer T1 has its one side connected to an output
2 terminal of the PWM controller 135 through a capacitor and its other side connected to a ground
3 voltage terminal. The field effect transistor FET1 also has its drain terminal connected to a high
4 voltage source B+ and its source terminal connected in common to one side of the horizontal
5 deflection coil H-DY and a collector terminal of a horizontal output transistor TR in the horizontal
6 output circuit 134 through a pulse transformer PT. The other side of the horizontal deflection coil
7 H-DY is connected to one side of the S-correction capacitor Cs, the other side of which is connected
8 to the ground voltage terminal.

9 The H/V processor constant voltage circuit 131 has its input terminal connected to a voltage
10 source V1 and its output terminal connected in common to an input terminal of the H/V processor
11 132 and one side of a capacitor, the other side of which is connected to the ground voltage terminal.
12 The horizontal driver 133 includes a field effect transistor FET2 having its gate terminal connected
13 to an output terminal of the H/V processor 132 and its source terminal connected to the ground
14 voltage terminal, and a horizontal drive transformer T2 having primary and secondary coils. The
15 primary coil of the horizontal drive transformer T2 has its one side connected to a voltage source V2
16 through a resistor and its other side connected to a drain terminal of the field effect transistor FET2.
17 The secondary coil of the horizontal drive transformer T2 has its one side connected to a base
18 terminal of the horizontal output transistor TR in the horizontal output circuit 134, the emitter
19 terminal of which is connected to the ground voltage terminal, and its other side connected to the
20 ground voltage terminal.

21 The operation of the horizontal deflection circuit 130 of the display device with the above-
22 mentioned construction will hereinafter be described.

23 When the display device is powered on, the PWM controller 135 is operated under the
24 control of the microcomputer 110 to output the PWM signal to the current amplifier 136. In the

1 current amplifier 136, the current amplification transformer T1 is excited in response to the PWM
2 signal from the PWM controller 135 to drive the field effect transistor FET1 connected to the
3 secondary coil thereof. As the field effect transistor FET1 is driven, a high voltage from the high
4 voltage source B+ connected to the drain terminal of the transistor FET1 is transferred to the
5 horizontal deflection coil H-DY and S-correction capacitor Cs through the pulse transformer PT to
6 be charged thereon.

7 Under the above condition, the H/V processor 132 outputs a horizontal pulse signal of square
8 wave to the horizontal driver 133 under the control of the microcomputer 110. In the horizontal
9 driver 133, the field effect transistor FET2 is turned on when the square wave pulse signal from the
10 H/V processor 132 is high in level, to excite the horizontal drive transformer T2. As a result, a
11 voltage is induced in the secondary coil of the horizontal drive transformer T2, thereby causing the
12 horizontal output transistor TR in the horizontal output circuit 134 to be turned on. As the horizontal
13 output transistor TR is turned on, it discharges the high voltage charged on the horizontal deflection
14 coil H-DY and S-correction capacitor Cs to the ground voltage terminal therethrough.

15 Thereafter, when the square wave pulse signal from the H/V processor 132 is changed from
16 high to low in level, the field effect transistor FET2 and the horizontal output transistor TR are
17 successively turned off. As a result, the high voltage from the horizontal deflection coil H-DY and
18 S-correction capacitor Cs is no longer discharged.

19 Then, the high voltage from the high voltage source B+ is again transferred to the horizontal
20 deflection coil H-DY and S-correction capacitor Cs through the field effect transistor FET1 and
21 pulse transformer PT in the current amplifier 136 to be charged thereon. Hence, the above-
22 mentioned operation is repeated.

1 Noticeably, the horizontal deflection coil H-DY is mounted to a neck portion (not shown)
2 of the display device so that electron beams emitted from the cathode ray tube can be deflected to
3 the left or right according to a direction of current flowing through the coil H-DY.

4 The S-correction capacitor Cs applies a parabola voltage to the horizontal deflection coil H-
5 DY to correct a linearity of center-to-left and right sides of a screen of the display device. The S-
6 correction capacitor Cs also performs a DC interruption function for preventing DC current from
7 flowing to the horizontal deflection coil H-DY.

8 If the power supply to the display device is interrupted during the operation of the display
9 device, the H/V processor constant voltage circuit 131 operates no longer due to interruption of the
10 voltage V1 as shown in Fig. 4a. As a result, the H/V processor 132 operates no longer, as well.

11 As the H/V processor 132 no longer operates, it outputs no pulse signal as shown in Fig. 5a,
12 thereby causing the high voltage charged on the horizontal deflection coil H-DY and S-correction
13 capacitor Cs not to be discharged. As a result, a voltage of about +120 to 160V remains at a node
14 A of the collector terminal of the horizontal output transistor TR.

15 Under the above condition, if the power supply to the display device is resumed, the H/V
16 processor constant voltage circuit 131 is driven because of application of the voltage V1, so as to
17 operate the H/V processor 132. As a result, the horizontal output transistor TR is operated.

18 At this time, a high voltage with a very high peak value (about +1.5 to 1.8KV) is
19 instantaneously generated at the collector terminal of the horizontal output transistor TR. As a
20 result, a surge current resulting from the instantaneous high voltage abruptly flows through a
21 discharge loop including the horizontal output transistor TR, thereby causing the horizontal output
22 transistor TR to be damaged.

23 If the horizontal output transistor TR in the horizontal output circuit 134 is damaged, no
24 horizontal deflection is performed on the screen of the display device, thereby causing a single line

1 to be vertically drawn on the center of the screen. As a result, the user cannot recognize the
2 information displayed on the screen.

3 Further, the peripheral devices and circuits may successively be damaged due to a short-
4 circuit resulting from the damage in the horizontal output transistor TR.

5 Fig. 3 is a detailed circuit diagram illustrating the construction of a display device with a
6 power interruption delay function in accordance with the present invention. The construction of this
7 drawing is the same as that of Fig. 2, with the exception that a power interruption delay charging
8 circuit 370 is provided according to the present invention. Therefore, like reference numerals
9 designate like parts and a detailed description thereof will thus be omitted.

10 In the display device of Fig. 2, the voltage source V1 is connected directly to the input
11 terminal of the H/V processor constant voltage circuit 131. However, in the display device of Fig.
12 3, the voltage source V1 is connected to the input terminal of the H/V processor constant voltage
13 circuit 131 through the power interruption delay charging circuit 370.

14 The power interruption delay charging circuit 370 includes a reverse voltage prevention
15 diode D1 having its anode connected to the voltage source V1 and its cathode connected to the input
16 terminal of the H/V processor constant voltage circuit 131, and a polarity capacitor C1 having its
17 positive pole connected to a connection point of the cathode of the reverse voltage prevention diode
18 D1 and the input terminal of the H/V processor constant voltage circuit 131 and its negative pole
19 connected to the ground voltage terminal.

20 The operation of the display device with the above-mentioned construction in accordance
21 with the present invention will hereinafter be described in detail.

22 When the display device is powered on, the high voltage from the high voltage source B+
23 is charged on the horizontal deflection coil H-DY and S-correction capacitor Cs through the field
24 effect transistor FET1 and pulse transformer PT in the current amplifier 136 and then discharged

1 through the discharge loop including the horizontal output transistor TR in the horizontal output
2 circuit 134. Such charging and discharging operations are repeated as stated previously with
3 reference to Fig. 2.

4 If the power supply to the display device is interrupted during the operation of the display
5 device, the voltage supply to the H/V processor constant voltage circuit 131 is at once stopped in the
6 display device of Fig. 2, as shown in Fig. 4a. However, according to the present invention, a
7 voltage, charged on the polarity capacitor C1 during the power supply, is applied to the input
8 terminal of the H/V processor constant voltage circuit 131, as shown in Fig. 4b, while it is
9 discharged. As a result, the H/V processor constant voltage circuit 131 does not immediately stop
10 the voltage supply to the H/V processor 132.

11 Noticeably, the reverse voltage prevention diode D1 is connected in series between the
12 voltage source V1 and the H/V processor constant voltage circuit 131 to protect the power supply
13 circuit by allowing the voltage charged on the polarity capacitor C1 not to be discharged to the
14 voltage source V1 at the power interruption state.

15 Because the voltage charged on the polarity capacitor C1 is continuously applied to the H/V
16 processor constant voltage circuit 131 until it is completely discharged, the voltage supply to the H/V
17 processor 132 is not interrupted immediately. Therefore, the H/V processor 132 outputs the
18 horizontal pulse signal continuously for a predetermined time period, as shown in Fig. 5b.

19 The continuous pulse output time of the H/V processor 132 is determined according to a
20 discharge time of the polarity capacitor C1. As a result, the continuous pulse output time of the H/V
21 processor 132 can be varied by adjusting the discharge time of the polarity capacitor C1.

22 While the output pulse from the H/V processor 132 maintains such a high voltage level as
23 to continuously drive the field effect transistor FET2 in the horizontal driver 133, the horizontal
24 drive transformer T2 continues to be excited to induce a voltage in its secondary coil, thereby

1 causing the horizontal output transistor TR in the horizontal output circuit 134 to remain at its driven
2 state. Hence, the high voltage charged on the horizontal deflection coil H-DY and S-correction
3 capacitor Cs can be sufficiently discharged. Namely, the discharge time of the high voltage charged
4 on the horizontal deflection coil H-DY and S-correction capacitor Cs is sufficient.

5 As apparent from the above description, according to the present invention, the power
6 interruption delay charging circuit is provided at the input terminal of the H/V processor constant
7 voltage circuit in the display device. The power interruption delay charging circuit can prevent the
8 horizontal output transistor from being damaged due to an instantaneous surge current when power
9 supply is resumed after power interruption. Further, the power interruption delay charging circuit
10 can prevent the peripheral devices and circuits from being successively damaged due to damage in
11 the horizontal output transistor.

12 Although the preferred embodiments of the present invention have been disclosed for
13 illustrative purposes, those skilled in the art will appreciate that various modifications, additions and
14 substitutions are possible, without departing from the scope and spirit of the invention as disclosed
15 in the accompanying claims.